

SYSTEM 1™

What it is, what it does, how it fits

INTRODUCTION

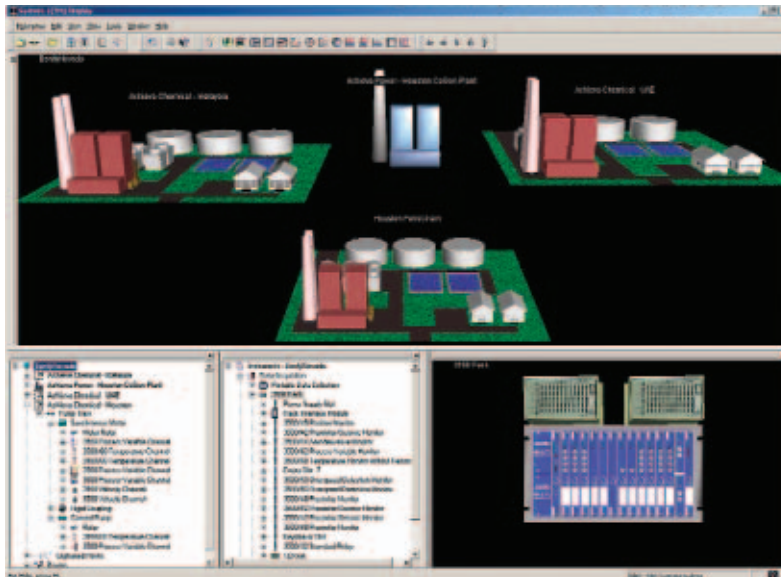
The release of System 1 software represents something far more than just the "next generation" in our online and offline condition monitoring software. While it would be natural to assume that System 1 is "Data Manager® 3000" with offline support for our new portable data collector, it is much more than that. Frankly, with our suite of Data Manager® 2000, Machine Condition Manager™ 2000, and Trendmaster® 2000 systems, our customers already have the world's best tools for managing their **machinery** assets. Then why System 1? It's simple. Plants need to manage more than just rotating and reciprocating machinery; and they need a management platform that allows them to integrate not only various condition monitoring technologies, but also all the various production assets in their plant – things like valves, boilers, heat exchangers, instrumentation, and any other physical equipment assets used in their processes. System 1 provides this functionality. In addition, it represents entirely new ways of integrating our own hardware and software products, unifying them into a single system, as well as integrating external plant systems such as process control, process historian, maintenance management, reliability, and other applications.

“Plants need to manage more than just rotating and reciprocating machinery; and they need a management platform that allows them to integrate not only various condition monitoring technologies, but also all the various production assets in their plant ...”

As this article goes to press, we’re releasing version 2.0 of System 1 software, already working on versions 2.1 and 3.0, and receiving an abundance of questions regarding this exciting new product.

We’re delighted with the level of interest, and in this article we’ll clarify where and how you can apply System 1 in your plant by answering the following questions:

System 1 is designed to address many asset types — not just rotating/reciprocating machinery.



- 1 What is a Plant Asset Management (PAM) System?**
- 2 What is System 1 and where does it fit in a PAM System?**
- 3 What does System 1 do?**
- 4 Where does System 1 fit relative to other Bently Nevada software?**
- 5 How does it differ from previous Bently Nevada solutions?**
- 6 How can it be deployed in new installations?**
- 7 How can it be deployed in existing installations to support legacy Bently Nevada hardware/software?**
- 8 Should I upgrade my existing Bently Nevada software to System 1?**
- 9 What improvements have been made relative to previous generations of Bently Nevada software?**
- 10 What can be expected in upcoming releases of System 1 software?**

What is a Plant Asset Management System?

1

In 1999, the ARC Advisory Group originated the terminology "Plant Asset Management" (PAM) to describe systems specifically intended to enable the full scope of asset management functions in a plant.

The primary elements of such a system include condition monitoring, maintenance management, and reliability management modules with integration to one another and to production (i.e., process control) and business systems.

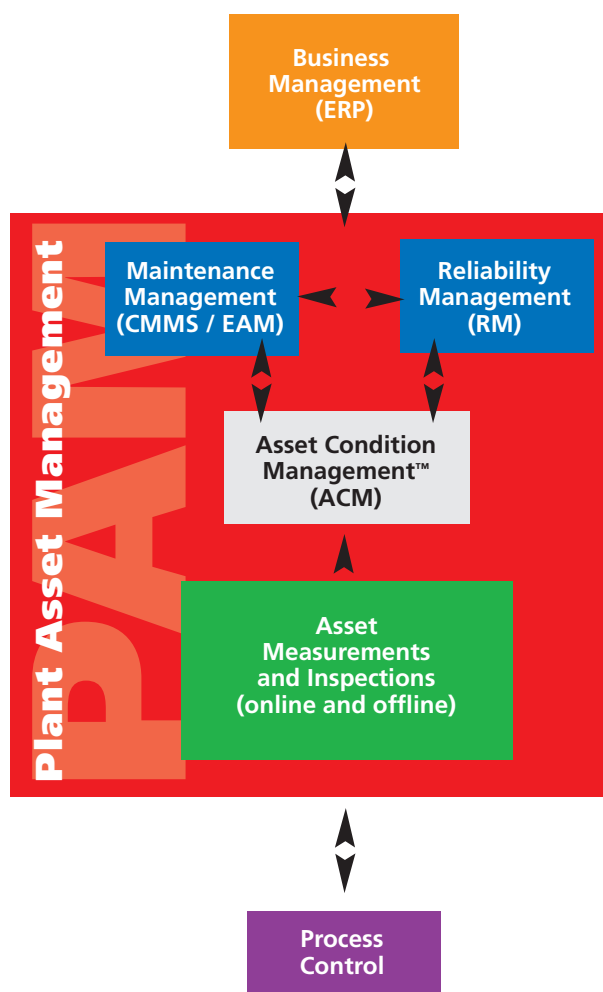
These three primary elements of a PAM system can be defined in simple terms as:

Asset Condition Management™ – Collects measurement data, both actual and derived, from the plant's production assets, and provides diagnostic tools to assess the condition of the assets and identify asset faults. It then makes this information available to other systems where appropriate action can be taken. The Condition Management module tells you *what is wrong with an asset, the severity of the problem, and what to do about it*. It also tells you when there isn't a problem with an asset – a significant, and sometimes overlooked, benefit.

Reliability Management – Provides tools, such as Weibull diagrams, Pareto charts, etc., for statistically analyzing asset reliability, and for generating reliability metrics. The system can also measure reliability improvements or degradation. The Reliability Management module tells *where to focus* in the overall asset management initiative, and measures success relative to goals.

Maintenance Management – Automates the maintenance process, records maintenance history, prioritizes maintenance, and manages the

continued on page 43



Basic Elements of a Plant Asset Management (PAM) system.

"Bently Nevada is one of the Condition Monitoring firms that can rightly claim they invented the whole concept of Asset Management in the first place."

— Control Magazine
April 2000

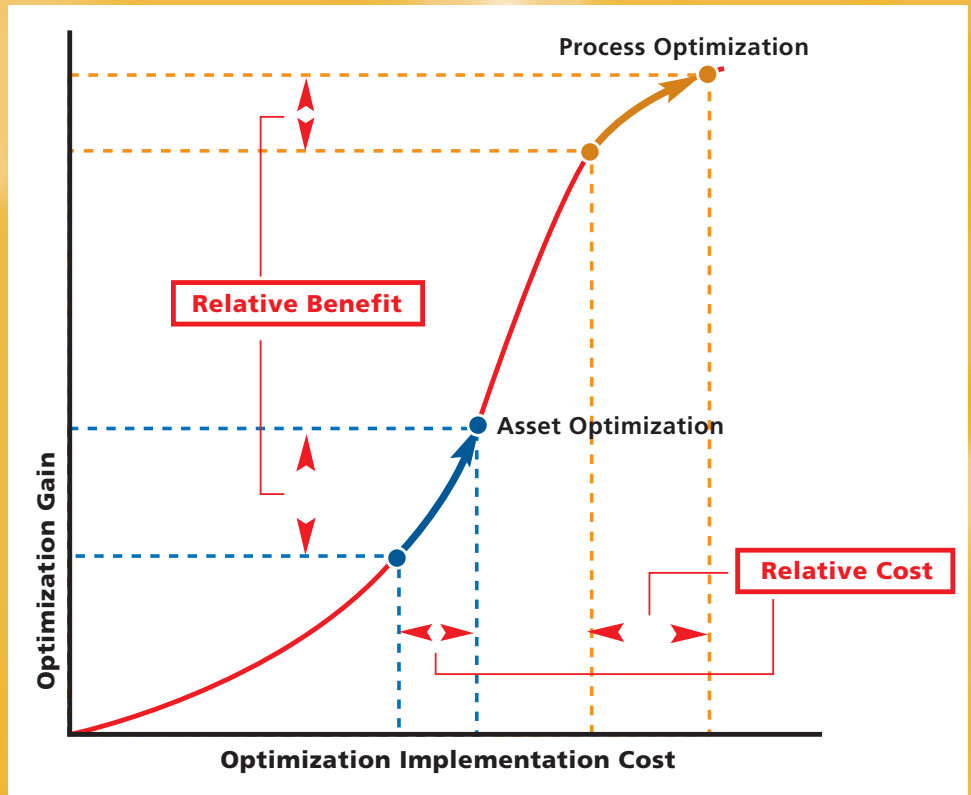
PLANT ASSET MANAGEMENT

What is it, why is it important, and what is the payback?

Over the past decade, the need to optimize the operation of process plants to gain competitive advantage has become the single most significant issue facing process industry enterprises.

This focus on optimization initially centered on process control and has resulted in significant improvements in process efficiency and performance.

Recently, however, process-related optimization has begun to reach the point of diminishing returns – those plants that have already implemented control optimization can still move up the optimization curve with further investment, but it is delivering less and less economic benefit. In contrast, there is another relatively untouched area of optimization that can provide enormous returns – the equipment assets that make the process run. This includes things like rotating and reciprocating machines, instrumentation, valves, vessels, piping, non-rotating (static) machines such as heat exchangers and boilers, and others. The process industries collectively refer to this new optimization discipline as “plant asset management.” It is focused on maximizing the performance and availability of production assets while minimizing their life-cycle costs.



“Is this quest for better asset-related decision-making information paying off? *YES.*”

Reflecting this past emphasis on process optimization, most process control systems now boast very sophisticated integration with business-level planning and scheduling systems, allowing plants to make enlightened business decisions based upon process-related considerations. However, the same cannot be said in most cases for asset-related information as part

of the decision-making process. This deficiency in asset-related information to aid in making business-level decisions is driving plants towards more sophisticated systems for assessing asset condition, just as it propelled them towards more sophisticated process control systems for more optimal business decisions. Is this quest for better asset-related decision-making information paying off? Yes. For those plants that have already been through one or more rounds of process optimization, they are finding that the same dollars spent on asset optimization will now yield better returns than if invested in further process optimization. Also, even the best optimized process is worthless if the assets prevent it from running as often as needed and at the desired throughput.

Not surprisingly, this situation has caused process enterprises to shift their investment focus to optimization of their production assets, where their investments can see greater returns. The result is an explosion of activity centered around Asset Management and Condition Monitoring. As confirmation, consider the following excerpts from a May 2001 report produced by the ARC Advisory Group^{*}:

"End-users in nearly every process industry across the board are increasingly adopting asset management as a strategy to improve process efficiency and enhance their return on assets (ROA)."

"A key driver is the need for business systems (ERP) to have access to critical machinery and plant asset information when making decisions regarding maintenance and manufacturing operations and evaluating the associated risks."

"Plant Asset Management Systems ... are expected to grow at a compound annual growth rate of 27% between now and 2005."

"Based on actual growth of over 14 percent from the previous year, PAM and CM is one of the hottest areas in an otherwise floundering process automation market."

"Despite the economic turmoil in North America and other parts of the world, PAM and CM solutions continue to experience high rates of adoption by users who find the cost savings compelling enough to adopt in large numbers in good times and bad."

"End-users are recognizing that the investment in PAM and CM will pay back five to ten times the initial capital investment in record time."

Clearly, **"plant asset management"** is where the action is occurring in today's process plants, and those adopting this strategy are reaping the benefits.

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^{*} Plant Asset Management and Condition Monitoring Worldwide Outlook, Market Analysis and Forecast through 2005, published May 2001 by ARC Advisory Group, Dedham, MA (www.arcweb.com)

"System 1™ has been designed to fill the role of an Asset Condition Management™ module today, and will expand to fill additional PAM functionality in the future."

continued from page 40

maintenance resources. These systems have historically been known as Computerized Maintenance Management Systems (CMMS), but are now generally known as Enterprise Asset Management (EAM) Systems – not to be confused with PAM systems. The role of this module is really in the *performance* of the maintenance function, once the Condition Management and Reliability modules have identified where to focus the maintenance resources.

It should be readily obvious that decision making in a plant draws upon all three systems. A Condition Management System might identify a problem and recommend a corrective action, but the Maintenance Management System would have to be consulted as well. Are the needed spare parts and tools available? If not, what is the lead time for ordering and the cost? Are the right personnel available? How much time should be allocated for the repair and are there other maintenance activities that should be performed at the same time? The Reliability Management System can analyze historical maintenance activity data to uncover patterns and recurring root causes that might otherwise go unnoticed. It can also identify where the biggest reliability problems are occurring and which problems should be tackled first for the best cost/benefit ratio.

What is System 1™ and where does it fit in a PAM System?

As discussed, a Plant Asset Management System has three primary components: a Maintenance Management module, a Reliability Management Module, and an Asset Condition Management module. System 1 has been designed to fill the role of an Asset Condition Management module today, and will expand to fill additional PAM functionality in the future. Bently Nevada describes System 1 with the terminology: *Machinery / Asset Condition Management Platform*. This terminology was chosen very deliberately, to convey specific aspects of the product's

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capabilities and scope of application. To understand the implications for PAM, consider each term in our description of System 1 independently:

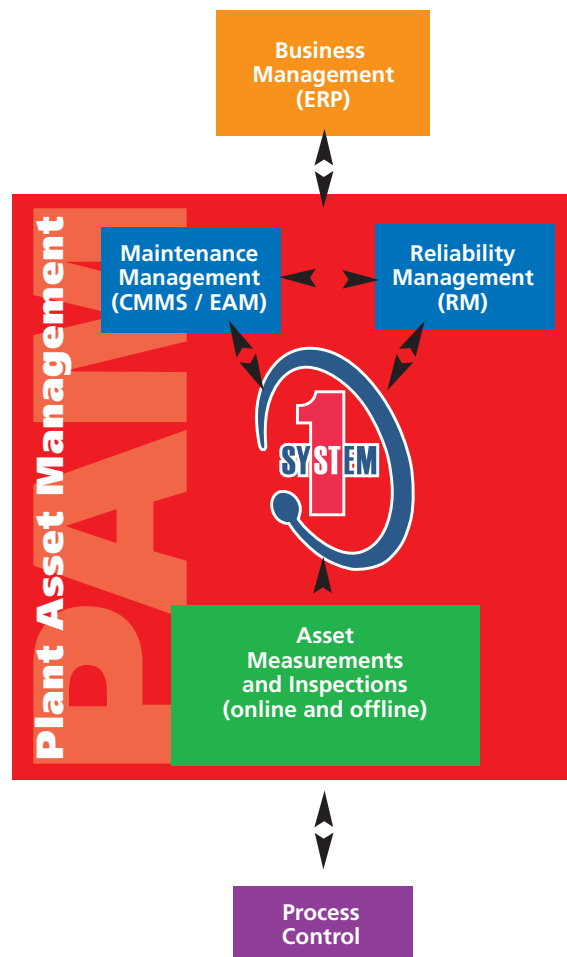
Machinery behavior understanding has been, and will continue to be, the primary strength of Bently Nevada. Although System 1 is capable of managing many other types of assets, we have embedded the knowledge and data presentation formats that are specific to machinery. This means it comes ready-made to manage machinery, while being flexible enough to configure for many other asset types.

Asset is a **very** important addition. Asset after machinery indicates that System 1 can be used to manage the condition of a wide range of assets. Not only will it support all types of rotating and reciprocating machinery, but also other production critical asset types including fixed equipment, thermal machines (i.e., heat exchangers and boilers), Bently Nevada instruments, and others. The capability to acquire data (static data, dynamic data, and/or transient data), directly from transducers and from a wide range of plant control and automation systems allows System 1 to act as an asset condition management system. As with machinery, the user can store, display, trend, correlate, and write Decision SupportSM rules for data from non-machinery assets.

Condition indicates the ability to supply users with Actionable Information[®] because it is Actionable Information, rather than data, that succinctly conveys an asset's condition. This provides users and other plant control and automation systems with automated, real-time condition indication and fault detection, allowing them to optimize asset life-cycle cost in consideration of production goals.

Management points to the fact that Bently Nevada *is not just protection monitoring*. Referring to our definition for machinery (and asset) management, (see sidebar on page 46), System 1 is specifically designed to deliver condition information long before a protection system is required to act (auto shutdown of the asset or machine).

Platform is a critically important term in understanding what System 1 is. Prior to the System 1 **platform**, all Bently Nevada software had been stand-alone applications. The introduction of System 1 in June 2000 marked the beginning of an integration of all Bently Nevada software applications. It is the platform upon which all new product development will be focused. **Platform** also describes how System 1 will act as the **one system** required to meet the Machinery/Asset Condition Management needs for process enterprises. It is not intended that a PAM system will require a multiplicity of Condition Management modules, but that a single application (System 1) will fulfill that function.



System 1™ is designed to fulfill all the requirements of the Asset Condition Management™ module for a Plant Asset Management System.

"System 1 can be used to manage the condition of a wide range of assets. Not only will it support all types of rotating and reciprocating machinery, but also other production critical asset types."

What does System 1™ do?

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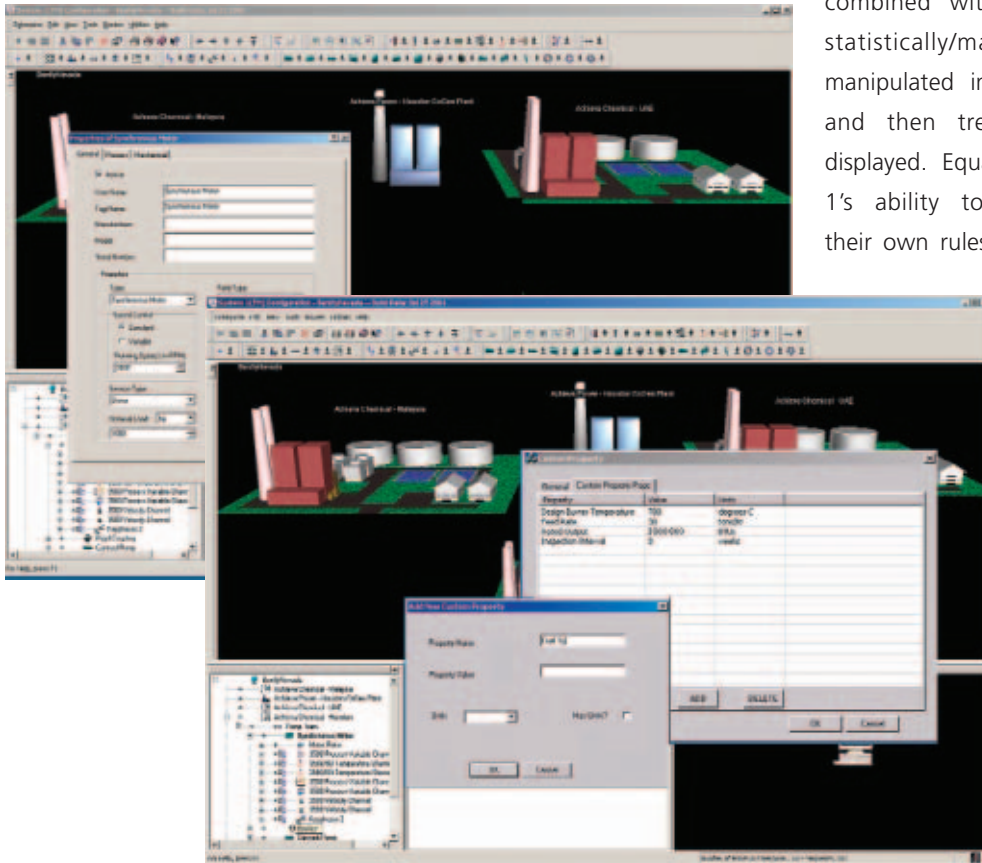
Those who have closely identified Bently Nevada with only rotating and reciprocating machinery condition monitoring in the past will find that System 1 expands considerably beyond this specific category of plant assets to cover any asset. As long as sensors can be placed on the asset to measure parameters of interest, be they temperature, flow, corrosion, speed, vibration, position, pressure, or others, the signal can be fed

into System 1. There, it can be combined with other variables or statistically/mathematically/logically manipulated in any manner desired and then trended, alarmed, and displayed. Equally important is System 1's ability to let users generate their own rules for automated analysis of this data.

The rule-building environment within System 1's Decision Support™ module incorporates the same basic ideas as pioneered in the RuleDesk™ utility in our existing Machine Condition Manager™ 2000 software. However, the ease with which non-vibration data

can now be introduced to the Decision Support module and analyzed has been considerably improved. Also, System 1's asset description capability allows the user to define as many attributes as desired for the asset,

continued on page 48



System 1's highly configurable asset registry allows you to fully describe not just rotating/reciprocating machinery assets, but any generic assets in your plant, as extensively as desired with totally definable properties and values.

BEST PRACTICES for Asset Condition Management™

Bently Nevada defines machinery management as:

A modern methodology to proactively optimize the productivity, long-term reliability, and maintenance costs of machinery over the plant life-cycle that provides real-time, or near real-time, feedback to the personnel responsible for the operating conditions acting on the machine. It includes:

Collection of relevant process and machinery condition data through an online system that can be used both locally and remotely;

Correlation of this data to understand the relationship between machinery stress, machinery malfunctions, and operating conditions;

Conversion of this data to Actionable Information® directed to the responsible people to act upon;

Communication of this information to the right people, at the right time, and in the right format. This occurs well before reaching alarm levels used by plant operations to manually or automatically shut down or remove the machine from service.

By substituting the word “asset” for “machinery,” you obtain an equally valid definition that captures the essential elements of properly managing **any** plant production asset. It necessitates the following capabilities in the Asset Condition Management™ module of a Plant Asset Management System:

Real-time and online

It is well-known that assets do not wear out linearly. They typically undergo periods of unusual stress, sometimes due to abnormal process conditions, during which a single hour of operation can introduce stress equal to thousands of hours of wear-and-tear under normal conditions. Intermittently checking an asset does not always catch problems in time; or, if it does, it may be able to identify what failed, but not why it failed. Industry is increasingly recognizing that the new standard is online, real-time asset measurements, just as it has long-ago embraced real-time process measurement and control. In fact, for a system to meet the ARC

Advisory Group's* definition of PAM, it must employ online, real-time technology for data collection and analysis.

Feedback

While it will always be necessary to provide information to **maintenance** personnel so they can fix identified asset problems, it is a relatively new realization in many plants that the **operators** are an equally important audience for asset condition information. Why? Because the **operators are in the unique role of being able to change process conditions, in real time, to prevent the asset from breaking in the first place.**

As mentioned, assets often wear out in a greatly accelerated manner simply because they are stressed by abnormal process conditions. In the words of one of our customers, **"Pumps don't die, they're killed."** The same can be said for many other assets, not just pumps. We have numerous examples of how our machinery condition monitoring systems have been used by operations personnel to change process conditions to prolong the life of an asset, without any detrimental effect on process throughput or quality. Without such information, the process would have happily chugged along while inadvertently strangling the life out of the asset. Thus, the ability for an asset management system to provide real-time measurements and real-time feedback are essential for success.

Correlation

Plant assets always interact with the process in some fashion. **Only by understanding the relationship between asset condition and process conditions can many root causes be isolated.** Is the asset being killed by the process? Is the process not the problem, but is it being adversely affected by the asset's performance? These questions can only be answered when the asset management system has the ability to correlate process data with asset condition data. This is why integration between the Asset Condition Management and Process Control Systems is so vital – it enables two of the most important aspects of asset management to occur: 1) correlation with condition measurements through the importation of process data to the Asset Condition Management module; 2) feedback to operators by exporting condition information to the Process Control System display consoles.

Actionable Information®

This is where the real value in an asset management system is delivered. All the integration in the world and the ability to access reams of data from multiple systems in an integrated user interface provides very little value in an age where

decisions must be made rapidly. **Today's plants want to "manage by exception" through the use of intelligent advisories and status annunciation.** They don't want to examine every bit and byte, plot and printout – there simply aren't enough people or hours. They expect their systems to turn data and measurements into plain-language advisories that identify what and where the problem is, how severe it is, and what to do about it. Bently Nevada coined the term "Actionable Information®," and it is now being routinely used to describe the kind of output people want from an asset management system. It is also important to note that for a system to be useful, its ability to generate Actionable Information must be automated and real-time. Many systems purporting to provide "Decision SupportSM" and "Actionable Information" do not do so in an automated fashion – data must be manually fed into the system and an audit of the data must be initiated manually. In contrast, Bently Nevada's Decision Support capabilities generate Actionable Information automatically at time-based intervals, upon alarm events, or using other user-configurable criteria. When assessing various aspects of a PAM system and its components, it is vital to ensure that the Asset Condition Management module is capable of providing Actionable Information automatically and in real time. Further, it is essential that users be able to customize this aspect of the system by embedding their own rules and knowledge.

Communication

This relates very closely to our discussion regarding feedback to operators. However, the audiences interested in output from an Asset Condition Management and PAM system extend well beyond operators. They include maintenance and reliability personnel, plant management, suppliers, and others. Bently Nevada has trademarked the phrase **"Actionable Information to the Right People at the Right Time®"** to convey this important concept. It is a central feature of our Condition Monitoring systems – particularly System 1TM. ORBIT

* *Plant Asset Management and Condition Monitoring Worldwide Outlook, Market Analysis and Forecast through 2005*, published May 2001 by ARC Advisory Group, Dedham, MA (www.arcweb.com)

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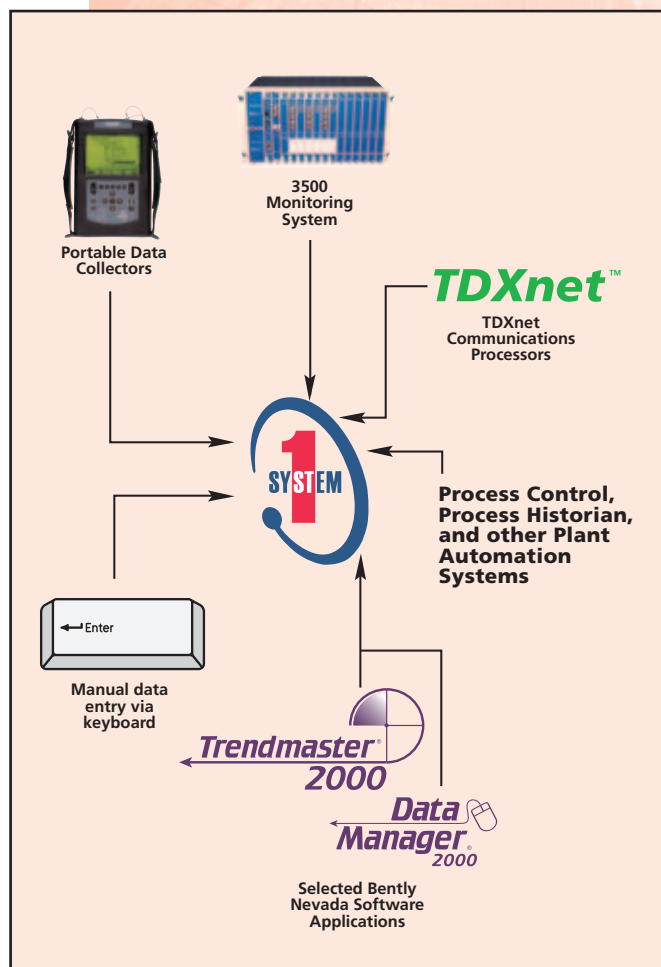
and then associate measurements with the asset. This is not limited to just rotating/reciprocating machinery.

Let's examine each of these basic aspects of System 1 in greater detail.

As part of the configuration process, the user

describes the asset to the system by entering appropriate data. For a rotating machine this might include things like machine type (a pump), bearing types (rolling element), rotative speed (1800 rpm), pump type (centrifugal, single-stage), seal types, manufacturer, model number, serial number, service location, and a host of other attributes. While templates exist for a wide variety of machines, System 1's flexibility allows the user to create a description for **any** generic asset, ranging from a control valve to a pressure vessel to a heat exchanger to a cracking tower nozzle. It really doesn't matter, since the user can create as many properties (such as "drive type") and associated values (such as "belt") to describe the asset as completely as necessary. An unlimited number of properties and associated values can be used with an asset, and the pre-existing templates for an asset included with System 1 can be augmented and customized with additional properties and corresponding values. This ability to create custom asset descriptions is a significant aspect of System 1 that distinguishes it from a platform only suitable for managing rotating machinery assets.

Asset Description



Measurements from appropriate transducers

and sensors can be introduced to System 1 in **four** ways:

- 1. Hardwiring** – Real-time static or dynamic signals can be hardwired into our monitoring systems or data acquisition hardware, which are compatible with virtually any generic voltage or current output sensor in addition to the wide

Measurements

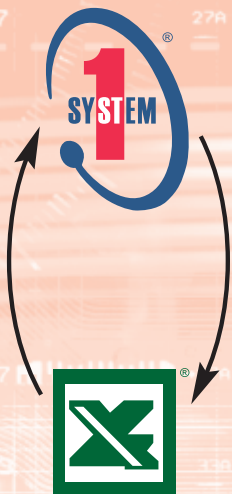
System 1 accepts inputs from a variety of systems in a variety of formats ranging from manual data entry to open protocols to hardwiring to portable data collector downloading.

range of standard vibration, position, pressure, speed, and temperature inputs we accept.

2. **Manual Keyboard Entry** – Data can be manually entered into System 1's database using the keyboard.
3. **Data Logger Downloading** – Data can be collected with our portable data collector, Snapshot™ for Windows® CE, or selected Personal Digital Assistants (PDAs), and downloaded into System 1's database.
4. **Import from other systems** – Data that exists in process control systems, process historians, or other control and automation systems can be shared with System 1 via OPC and NetDDE protocols. This eliminates the redundancy of hardwiring signals into both systems and instead allows them to share data as needed. System 1 also allows you to import/integrate data from your existing Bently Nevada software, such as Data Manager® 2000 and Trendmaster® 2000.

These combine to give System 1 the ability to obtain almost any measurement that might be required for condition monitoring purposes, and again underscore its flexibility for use on virtually any asset – not just rotating or reciprocating machines. Measurements can be associated with one or more assets. One example might be ambient outdoor temperature, which could be associated with every outdoor asset in the entire plant. Or, a measurement might be associated with only a single asset, such as the accumulated travel of a control valve stem.

Manipulation



Move data easily between System 1 and Microsoft® Excel to create derived and calculated variables in addition to direct measurements.

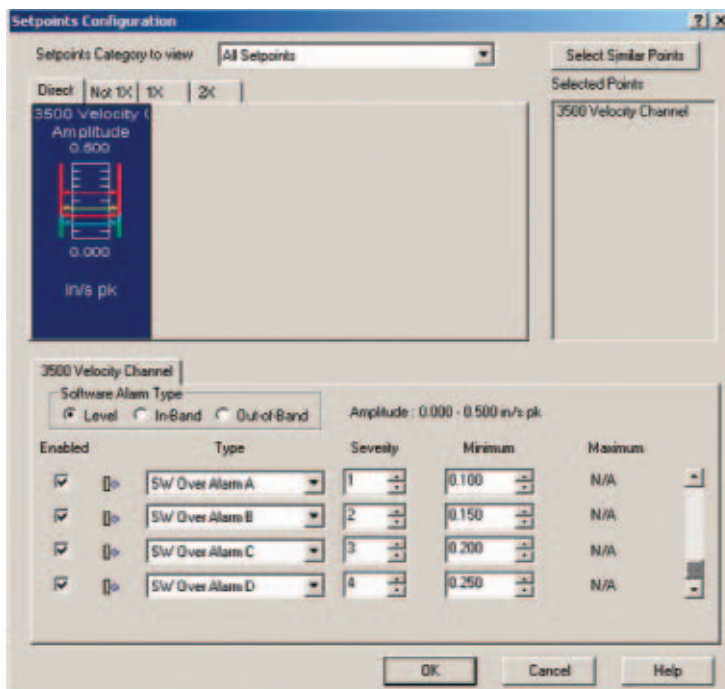
Once the basic measurements have been introduced to the System 1 database, they can be manipulated in almost any manner desired. Powerful utilities exist for moving data from the System 1 database to Microsoft® Excel where it can be manipulated mathematically, statistically, logically, and in other ways using the extremely large function library within Excel. Virtual measurements can be created, derived or calculated values can be obtained, and these results can then be automatically imported back into System 1 where it can be trended, compared against alarms, and run through Bently Nevada's knowledge base and rule set or subjected to custom embedded rules written by the user.

Data manipulation isn't limited to individual values, either. Entire arrays of data could be sent to a spreadsheet for curve fitting, statistical analysis, and other analysis to compute things such as "time to alarm," "useful life remaining," "fuel cost per minute," "corrosion rate as a function of gas composition," and anything else that could be mathematically derived. System 1's flexibility means that direct measurement and calculated or derived measurements can be treated exactly the same – displayed, trended, alarmed, compared, etc.

Another useful aspect of System 1's data manipulation capabilities is its ability to handle data in both real-time and offline modes. In real-time mode, you can export measurements as they are obtained by System 1, create calculated or derived values in Excel, and import them back into System 1's database, just as though they were "direct" measurements made by a real sensor. The user can also manipulate data "offline" by extracting historical data from System 1's database using industry-standard SQL (Structured Query Language) calls, paste this data into Excel or other applications, manipulate and condition the data as desired for analysis, and even reintroduce it to the System 1™ database again as a manual entry.

For users with specific requirements to calculate and display thermodynamic performance data, our Bently PERFORMANCE™ System Extender™ can be plugged into System 1 to add this capability. For those users who want to make calculations and create derived values that are generic in nature, rather than specifically related to thermodynamic performance, special interfaces for importing/exporting data to Microsoft® Excel are available with capabilities as described above.

Trending: Direct, calculated, and dynamic (waveform) data are automatically trended and archived using System 1's powerful trending capabilities. See the sidebar on page 51 for details on this important aspect of System 1™.



Alarming: Another

powerful aspect of System 1 is its ability to compare any measurements in the system, whether "direct" or calculated, against totally configurable software alarm setpoints established by the user. This is in addition to any alarms that the hardware

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Highly configurable software alarms and user-assignable severity levels are available in System 1 for any variable – whether directly measured or derived.

SYSTEM 1 – TRENDiNG

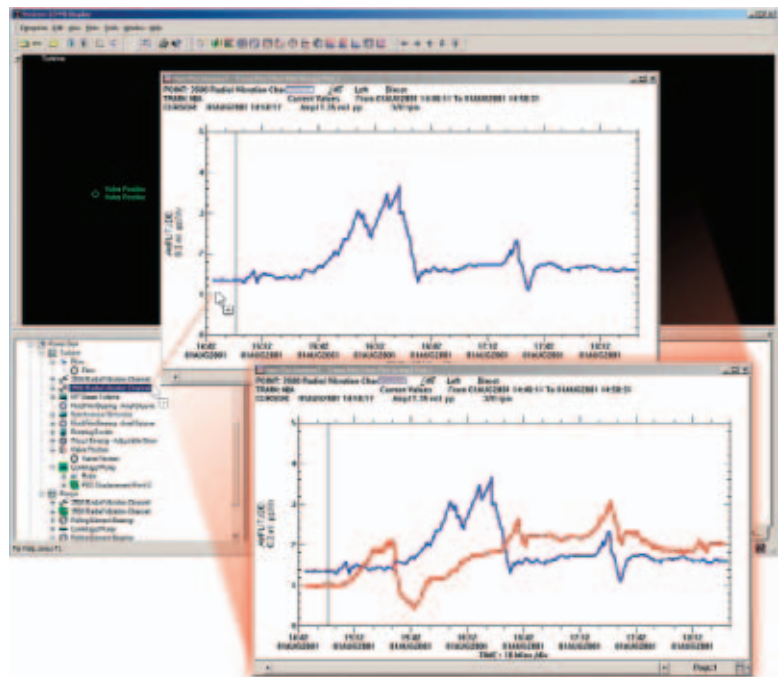
Unparalleled TRENDiNG Capabilities

Powerful new trending capabilities are one example of the many innovations in machinery / asset condition management brought to you by System1™.

The creation of advanced and more user-friendly trending capabilities in System 1 overcome the limitations common to many other trending packages on the market, and significantly improve upon the trending capabilities of our own software applications offered in the past.

System 1 version 2.0 provides trend data resolution better than four seconds between samples. This includes all measurements coming into System 1 from compatible hardware or via digital interfaces from process control and other systems. System 1 trends and stores not only static data, but also synchronously and asynchronously sampled dynamic waveform data in both time- and frequency-domain formats, allowing you to “play back” dynamic and static data from events such as alarms, startups, or specific dates/times, much as a flight recorder on an aircraft is used to capture *all* cockpit activity.

In addition, derived values created by the user using our automation interface to compatible spreadsheets, such as Microsoft® Excel, can also be trended, but generally at slower speeds (several times per minute). Any data manipulation functions (such as statistical, arithmetical, and logical) found in compatible spreadsheets can now be used on real-time and archived data within System 1. This ability to handle



Drag-and-drop capabilities make on-the-fly creation of multi-variable trend plots for correlating data easier than ever. Simply select the point(s) to add to an open trend plot, drag-and-drop the variable(s) into the plot, and the trend plot instantly updates with the new variable(s). Drag-and-Drop is just one of the many enhancements you'll find in System 1's powerful trending capabilities.

both direct and derived values results in a truly flexible trending package that can **customize data** to the requirement of individual applications and enterprises.

Plans also exist to increase trend resolution even further in future releases of System 1 to a remarkable one second for select communications processors and interface methods.

Storage Limitations and Mandatory Trend Compaction? Gone!

With System 1 the user specifies the amount of storage to reserve for the historical database. Have 30 GB at your disposal? You can now use all of it, in

any manner desired. This means that you can collect, store, and view high-resolution static and dynamic data without losing any of this data to compaction methods and without the constraints of fixed trend intervals. Choose a start and end date for your trend display, regardless of the interval, and be assured that all your data is there and available for viewing in one continuous trend – no more pasting together fixed interval trends to get what you want to see and no more lost data. If you prefer to compact the data, the criteria for data compression has now been made totally configurable through the use of user-definable “change filters” on every measurement. Bently Nevada’s change filtering capabilities improve upon those available in most other industrial trending packages by allowing you to specify not just “percent of change” criteria for storing data, but also max and min storage intervals, to ensure that too little (or too much) data is a thing of the past.

Drag-and-Drop Correlation

Using System 1’s drag-and-drop method of plot configuration, correlation of data has never been simpler. When viewing a plot, the user can simply select a point from the navigation tree, drag it over to the trend plot, and drop it. The point will automatically be configured and displayed on the selected plot along with any other variables already being viewed – add as many points as you want, from any location or asset, to a trend plot.

All the information without all the clutter

A number of display features have been included to speed data and information access as well as minimize plot clutter resulting from too much information being displayed at one time. Consider these important improvements introduced with System 1:

- *Plot headers can be removed to maximize the plot size.*
- *Selecting an individual trend line on a multi-variable plot causes engineering units specific to that point to appear on the right-hand scale.*
- *Time- and event-focused trend presentations allow the user to globally define the data to be displayed. For example, you can now specify not just an exact start/end date, but also real-time data, the last XX days, a specific startup/shutdown, or alarm event. All data meeting this criteria will then be displayed.*
- *Events such as alarms and journal entries can now be displayed on trend plots, where an icon represents each event type. When the mouse is passed over any of these icons, the particulars of the event are instantly displayed.*
- *Plot zooming of amplitude scale ranges and intervals (rubber band zooming) is included, greatly reducing the time spent by users drilling down to a specific interval of interest with an appropriate amplitude range.*
- *Whenever other data is available but not displayed, the user can simply scroll to that unseen data.*
- *Customization of the plot display gives users the ability to create plots specifically tailored to their requirements. For example, plots that are to be inserted into reports using third-party office automation tools such as word processors can be configured to accentuate details through user selection of colors for trend lines, backgrounds, and grids. This greatly improves clarity and accommodates individual preferences.*

Advanced trending is just one of the many impressive new features found in System 1 – combined, these features form the industry’s most powerful and capable tool for machinery / asset condition management. ORBIT

continued from page 50

connected to System 1 might generate, which are also included in System 1's database and annunciated via the Event Manager and System 1's highly flexible notification features. Level-type software alarms, either over or under, can be associated with a measurement, and in-band and out-of-band alarms can also be established. Up to four software alarms (in addition to any hardware alarms) can be associated with any single measurement. In addition to the types of alarms, the user can also establish a desired severity level. For example, an under-level alarm might be given a severity level of 1, while an over-level might be given a severity level of 2. Four different severity levels are available for association with any alarm type. This ability to establish varying types of alarms as well as severity levels, in ways that are totally configurable by the user, is another very significant aspect of System 1 that extends its usability well beyond just rotating and reciprocating machinery.

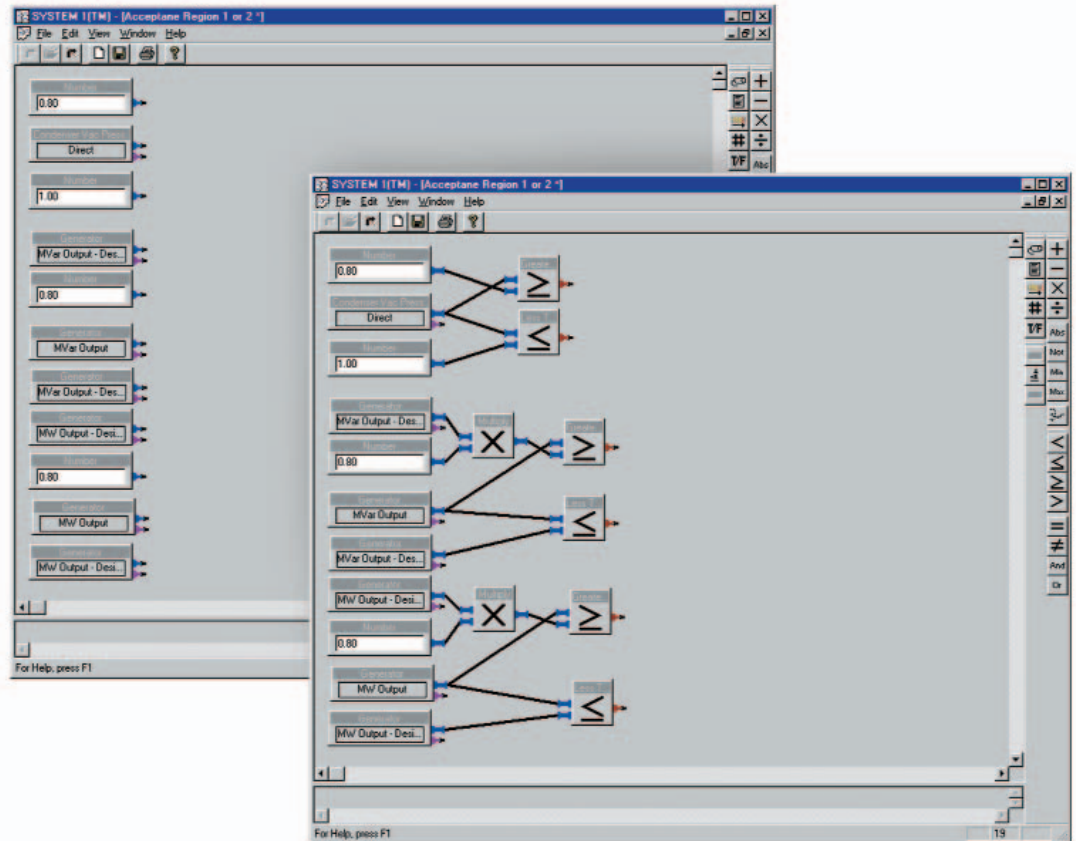
Decision SupportSM: Once direct or calculated values and statuses exist in System 1 through appropriate measurements and calculations, this data can be fed through our Decision SupportSM module where data is converted to Actionable Information[®]. The data types analyzed in the Decision Support module can be both static (trends and individual values) and dynamic (waveforms). Essentially, Actionable Information can be thought of as a highly intelligent alarm. Rather than a message from a simple software alarm in the system stating "out-of-band temperature alarm at heat exchanger outlet: severity level 3," our Decision Support module could have rules written that combined this temperature condition in the heat exchanger with flow and other measurements to clearly identify why there was a temperature alarm and what to do about it. For example, a hole in the piping might be the culprit, as ascertained by flow measurements made at the inlet and outlet ends of

the heat exchanger. A hole in the tubing might carry severity level 4, along with a specific recommendation about how to take corrective action. The rules to ascertain the problem, the severity level, and the recommendation about corrective action to take are all totally configurable with System 1's Decision Support module.

It is important to note that although the Decision Support module comes pre-configured with a knowledge base and rule sets specifically for rotating and reciprocating machinery, there is nothing that precludes users from writing their own rules to address other asset types – in fact, that is why we specifically chose a non-rotating equipment asset (a heat exchanger) in the example above. It illustrates how our Decision Support module is flexible enough to address any asset. The only reason it comes pre-configured for rotating machinery is because this is the specific category of assets for which Bently Nevada has subject matter expertise for diagnostics. It is fully expected that customers and the suppliers of their various plant equipment assets will possess the subject matter and diagnostic expertise to develop their own rules to augment our own, and address other asset types.

**"Essentially,
Actionable
Information[®]
can be thought
of as a highly
intelligent
alarm."**

Our RuleDesk™ utility is an integral part of System 1's Decision Support module, allowing users to generate their own rules without writing a single line of code or learning a complex programming language. Essentially, RuleDesk allows the user to enter a rule in much the same fashion as they might write it on a chalkboard, using boxes, arrows, text statements, and appropriate mathematical/statistical/logical operators.



Notification: As discussed above,

Actionable Information® can be best thought of as an intelligent alarm. Events generated in the Decision Support module and hardware/software alarms can be delivered to users in a variety of formats, ranging from e-mail messages, pager and cell phone notification, and delivery to special “personal notifier” applets running on desktop computers. The notifier module is highly configurable, allowing you to direct which people will receive notification of events, under what circumstances, and using what delivery mechanisms. For example, one user might only wish to be alerted via pager to events related to control valves in their particular segment of the plant and only for severity levels greater than 1. Another user might prefer e-mail notification for any event, originating anywhere in the plant. Still another user, perhaps someone with responsibility for a region encompassing several plants, might

wish to receive cell phone notification for any severity level 4 alarms for any plant within his region. The notifier capabilities of System 1 are what make it practical to deliver Actionable Information to the Right People at the Right Time®.

Plots and reporting: With all the

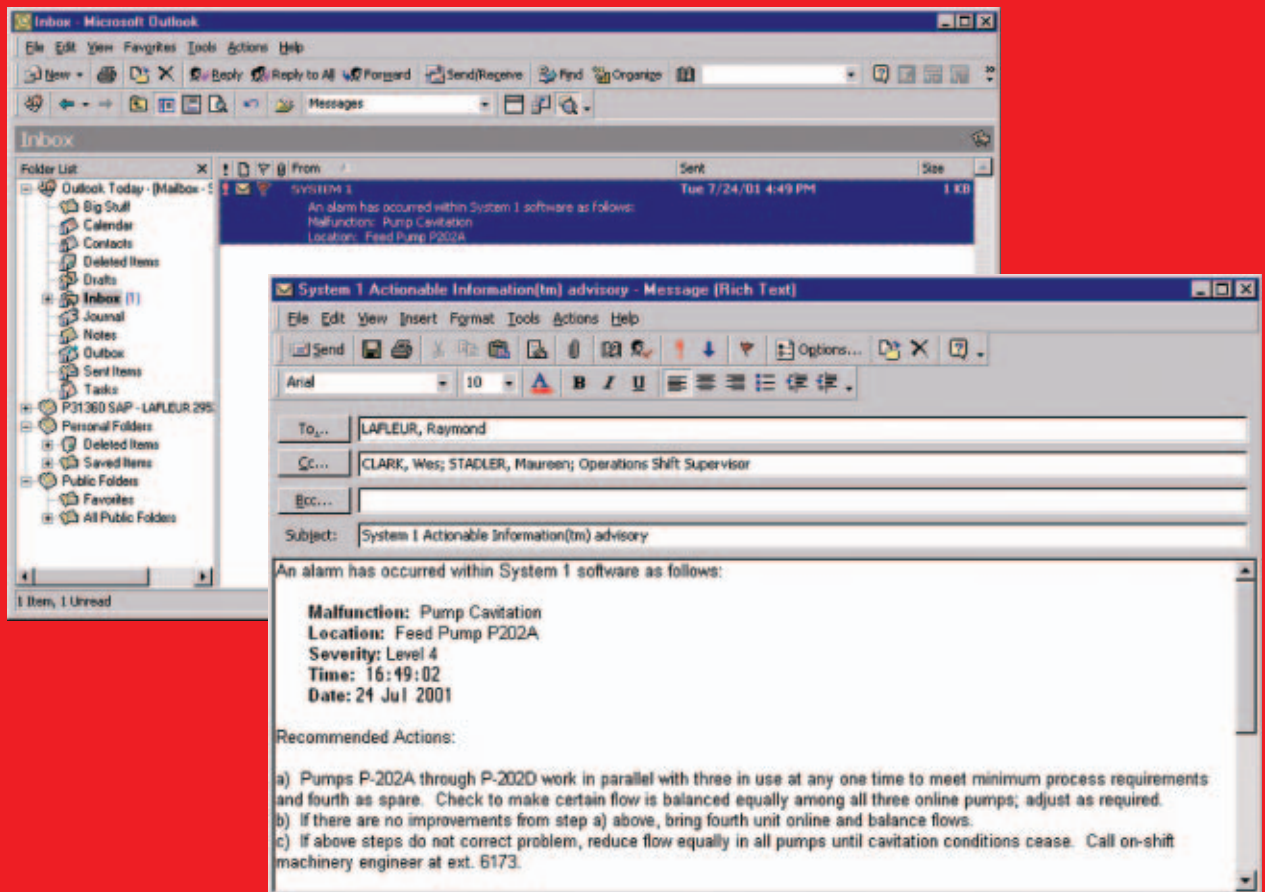
emphasis on high-level advisories and embedded intelligence, you might be tempted to think that the ability to drill down to detailed plots, waveforms, event lists, and other diagnostic tools has been sacrificed. While we expect that users will obtain the most value in managing their assets based upon the alarms and Actionable Information generated in System 1, rest assured that you can still access raw data, plots, and low-level information with as much detail as needed. In

“System 1™ is different because we expect that users will interact with the system very differently than they have with previous generations of our software.”

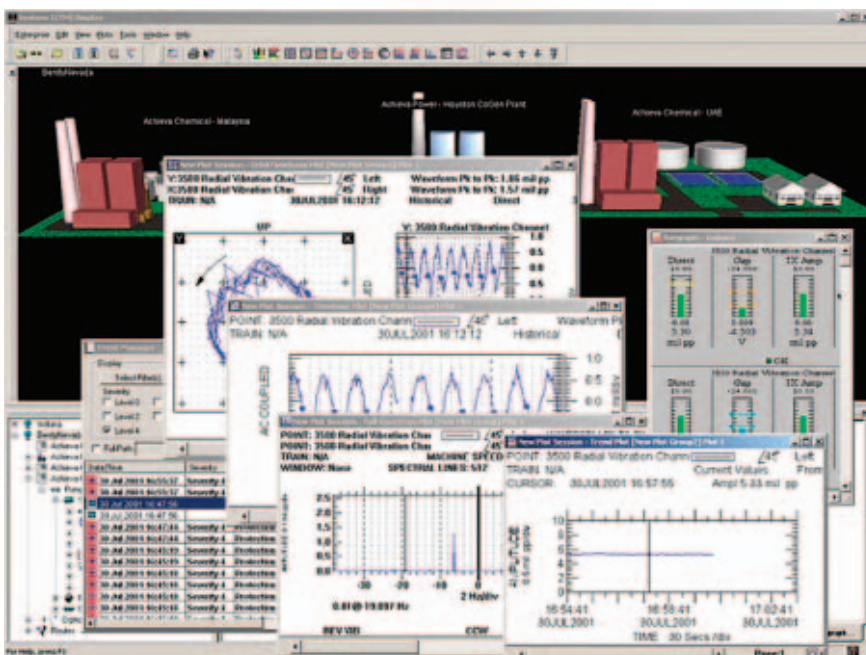
fact, you'll find System 1 is considerably more capable, flexible, and powerful than any previous systems we have ever offered for in-depth data analysis. However, we have specifically avoided focusing in this article on the “plot surfing” enhancements made to System 1, since we don't want to imply that it is simply an improvement on our previous software, intended to be used in exactly the same fashion as our previous solutions.

System 1 is different because we expect that users will interact with the system very differently than they have with previous generations of our software. In the past, focus was on points and plots and the specialized knowledge to interpret data. Today's focus is on reporting by exception those assets that are operating outside of expected parameters.

NOTIFICATION



System 1's powerful notification features deliver Actionable Information® in a variety of formats, ranging from pager to cell phone to desktop annunciator applets to e-mail.



“Think of rotating machinery as merely a subset of System 1’s condition monitoring capabilities.”

While System 1 focuses on allowing you to manage your assets by exception using Actionable Information, it doesn’t sacrifice any of the lower-level diagnostic plots you may need for in-depth analysis. You receive all the detail and diagnostic tools – and more – that you’ve come to expect from Bently Nevada, but it is no longer limited only to rotating machinery.

4 Where does System 1™ fit relative to other Bently Nevada software?

We hope it is apparent by now that System 1 is not simply the next generation of our machinery management software. It is truly designed to manage and measure conditions from other assets as well. This makes it **distinctly different** from anything else we have ever offered. Think of rotating machinery as merely a subset of System 1’s condition monitoring capabilities. Essentially, System 1 is designed to be a common user interface, analysis platform, database, Decision Support engine, and notifier for the condition of all the assets in your plant. It is designed to do all the things our previous software, aimed strictly at rotating machines, could do, but to also add capabilities for virtually any production asset in your plant. To the extent that System 1 will not be made compatible with every communications processor and hardware data acquisition device we have made in the past, it does not obsolete Data Manager® 2000, Machine Condition Manager™ 2000, or Trendmaster® 2000 software at this time. Instead, these applications can be integrated with System 1 as a method of providing compatibility with and support for older hardware. When customers use

selected existing hardware (TDXnet™ communications processors and Snapshot™ for Windows® CE portable data collectors) and hardware currently under development, System 1™ does obsolete older software. It depends entirely on the Bently Nevada hardware that you wish to connect to System 1™ as to whether it exists along side of, or in place of, our older software.



How does System 1™ differ from previous Bently Nevada solutions?

There are four primary differences:

1. System 1 is designed to address all or most of the production assets in your plant, not just rotating and reciprocating machinery.

These other assets are not “second-class citizens” in the System 1 architecture. Data from these assets and their associated sensors can be manipulated, trended, alarmed, and run through System 1’s Decision Support engine just like data from a rotating or reciprocating machinery asset. Custom rules can be written in the Decision Support module, allowing you to embed your own expert knowledge; and alarm and event notification, whether generated within the Decision Support module or within the basic alarming functions of System 1, can be transmitted to the appropriate people using System 1’s extensive notification capabilities.

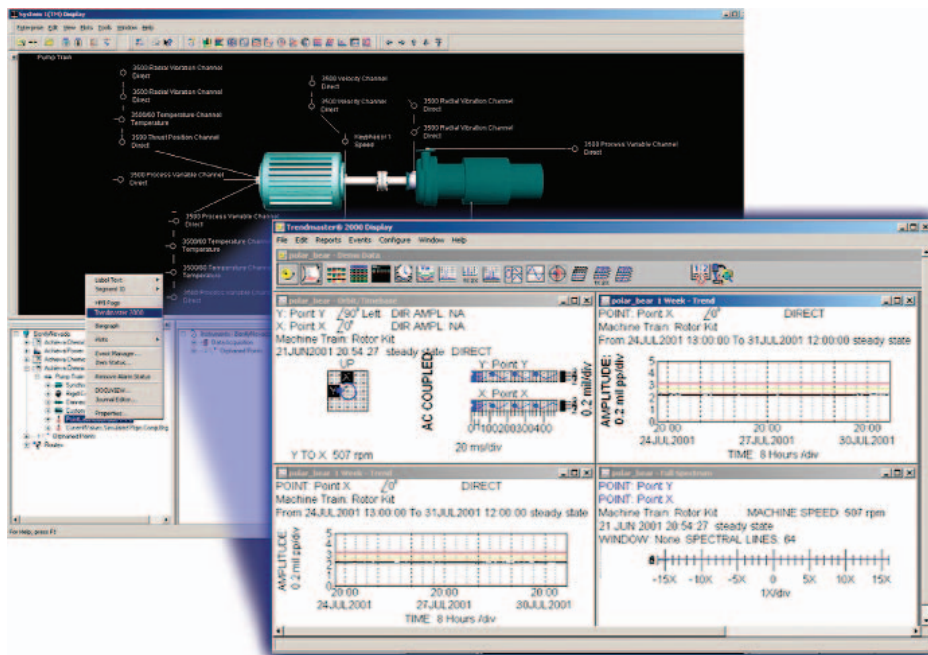
2. System 1 integrates the Decision Support function more extensively, making it a central and essential part of managing any asset.

Our previous software products treated the Decision Support function as more of an add-on feature, limited its use primarily to rotating machinery, and audited data only when triggered to do so. With System 1, the Decision Support function is far more integrated in every respect and **continuously**

audits **every** byte of data in real time. We are also taking a significant step forward in helping customers convert their asset data into Actionable Information by allowing the system to work with any data present in the System 1 database, whether directly measured or derived, and regardless of whether it is associated with a rotating machine or other asset. System 1’s Decision Support module also incorporates our RuleDesk™ utility, first introduced in our Machine Condition Manager™ 2000 product. RuleDesk allows users to write their own rules without the need to learn special programming or cumbersome rule development applications. The combination of real-time and automated, rather than manual, Decision Support capabilities; a simple-to-use rule development environment that allows users to embed their own knowledge in the system; the ability to work with any data from any asset in the System 1 database; and, powerful notification features will make the Decision Support module the most valuable part of a System 1 implementation.

3. System 1 allows users to “plug in” their existing Bently Nevada software, rather than waiting for direct support of older hardware.

Historically, each time Bently Nevada released a new software platform, we developed drivers that would directly support the existing hardware (communications processors) supported by the previous version of our software.



Existing Data Manager® 2000 and Trendmaster® 2000 software systems can be “plugged into” System 1, providing backward compatibility with existing Bently Nevada hardware you may have installed. This provides the convenience and power of a single navigational environment, improved user interface, and other System 1 enhancements.

System 1™ allows users to “plug in” their existing Bently Nevada software, rather than waiting for direct support of older hardware.

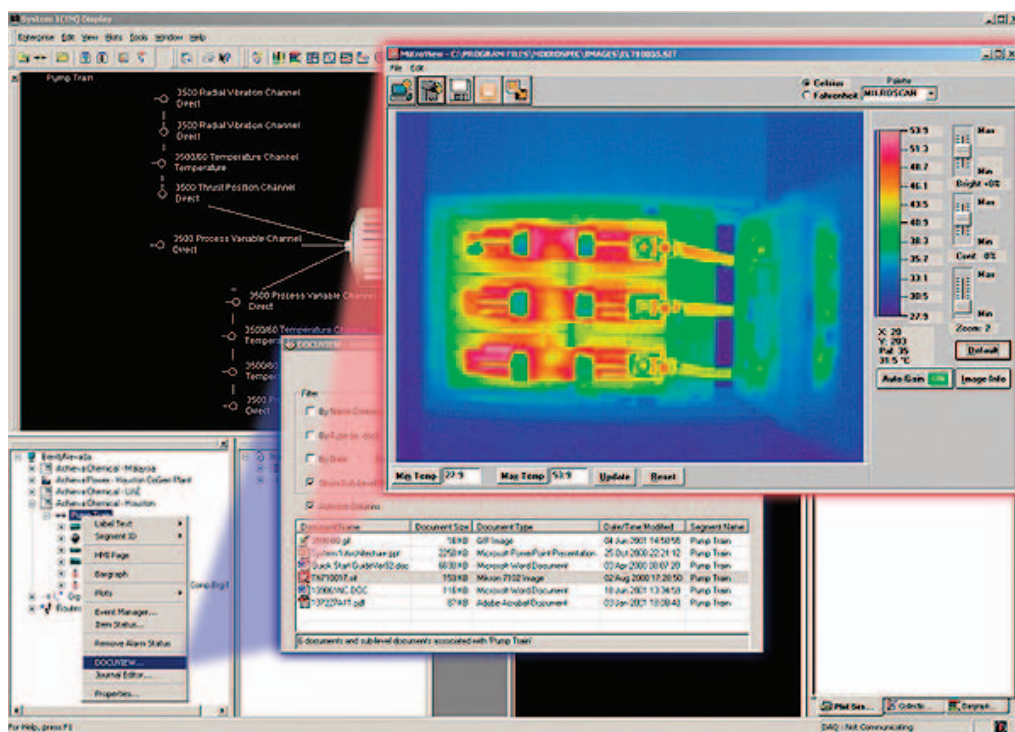
With System 1, we have adopted a different approach. Those customers using our newest hardware, and future hardware that we will develop, will find that it is “System 1 Enabled,” meaning it is directly compatible with System 1 software. Those users of older hardware need not despair. They can simply retain the Bently Nevada software they are already using, such as Data Manager® 2000 and Trendmaster® 2000, and plug it into System 1 using our special interfaces. This allows the user to benefit from an updated and common user interface and extends System 1’s RuleDesk™ capabilities to Trendmaster® 2000 data — a frequently requested enhancement. Once the data from these systems is in System 1, all the power of System 1 can be harnessed, such as manipulating the data, providing more alarming capabilities, enhanced Decision Support, enhanced

correlation with process conditions and other asset conditions, radically improved trending capabilities, a single navigational environment, right-click linking to any document associated with the asset (manuals, web pages, inspection reports, etc.), extensive notification tools and capabilities, and others. This essentially means that the Bently Nevada products you are currently using for online condition monitoring are instantly compatible with, and can benefit from, System 1’s powerful capabilities.

4. System 1 provides far more integration than our previous software packages. With System 1, online and offline data acquisition are integrated into a single system and database. However, System 1 is far more than just an integration of the

various types of data acquisition devices that previously relied upon different software applications. System 1 also provides for more comprehensive integration with process control and plant historian systems, or other plant automation systems supporting NetDDE and OPC protocols. The variety of data types and the speed at which they can be collected have been dramatically improved, along with the ability to use the time stamps affixed by the source device for better correlation. The ability to configure data obtained from these digital interfaces has also been improved enormously, allowing the user to associate such data with non-machinery assets.

Another area of enhanced integration is System 1's ability to link to any document or file by simply right-clicking on the asset's icon and selecting from a drop-down list of user-definable links using our Bently DOCUVIEW™ System Extender™, a plug-in software module that adds document linking features to System 1. Virtually anything can be linked to – a plot, a web page, an instruction manual, an inspection report, a thermography image, an oil sample report, etc.



With our Bently DOCUVIEW™ System Extender™ plug-in module, you can extend the basic capabilities of System 1 software, allowing you to associate an asset with specific links to any document, file, web page, or other resource simply by right-clicking on the asset's icon.

DOCUVIEW



How can System 1™ be deployed in new installations?

For new installations, critical machinery would be fitted with our 3500 Series Machinery Protection Systems and corresponding communications processors, and general-purpose machinery and other equipment where a walk-around (offline) approach is satisfactory would be addressed with our portable data collector, Snapshot™ for Windows® CE. These are directly supported by System 1 software. Less-critical machinery requiring online monitoring would use our Trendmaster® 2000 system, consisting of both wired and wireless capabilities for acquiring data. Although our Trendmaster® 2000 hardware components are not yet supported by System 1™, our Trendmaster® 2000 software **is** compatible with System 1, able to share data and plots, and allowing this data to be run through System 1's extensive data manipulation, alarming, trending, RuleDesk™, and notifier functions. For the user, this software integration is quite seamless and they can use a common interface to select assets and points, view alarms and trends, and see the entire plant and all associated assets. In the near future, native support in System 1 for Trendmaster 2000 hardware will be offered, providing backward compatibility with existing sensors, cables, and Transducer Interface Modules (TIMs). However, depending on the Signal Processing Adapter (SPA) hardware in use, it may be necessary to upgrade this component for compatibility with System 1. Once introduced, this will obsolete the need for Trendmaster 2000 software altogether.

To address non-rotating machinery assets, appropriate data could be obtained using either: a) an appropriate network protocol such as NetDDE or OPC to communicate with a process control system or other plant automation platform where the data already exists; b) hardwiring condition monitoring sensors into appropriate Bently Nevada data acquisition hardware such as TIMs, communications processors, or monitors.



How can System 1 be deployed in existing installations to support legacy Bently Nevada hardware/software?

Customers who already have Data Manager® 2000 and/or Trendmaster 2000 software can simply “plug in” this software to System 1, as noted earlier. This holds true for Data Manager® 2000 installations using Bently PERFORMANCE™ and Machine Condition Manager™ 2000 as well. This approach provides support for any existing communications processor or Trendmaster 2000 hardware that may already be installed. At this time, the only existing communications processors that will definitely be supported directly by System 1 are TDXnet™ when connected to 3500 or 3300 Machinery Protection Systems. We will also provide support for existing Trendmaster 2000 hardware, but it may require users to replace their existing Signal Processing Adapter (SPA) card(s). Customers wishing to integrate their portable data collection program into System 1 can do so by upgrading their portable data collection hardware to Bently Nevada's Snapshot™ for Windows® CE.



Should I upgrade my existing Bently Nevada software to System 1™?

For many users, the most appropriate course of action is to install System 1 on top of your existing Data Manager® 2000 and/or Trendmaster® 2000 software.

This will allow you to receive immediate value from an improved user interface, trending capabilities, integration with our portable data collector, and connectivity to other plant systems and applications. However, perhaps the largest benefit is that you will then have a powerful platform for managing the condition of more than just rotating machinery – you can add other important plant assets as well. For those of you who have our most recent (3300, 3500) machinery protection systems connected to TDXnet™ communications processors, you will find it very easy to upgrade to System 1 and eliminate the need for Data Manager 2000 software entirely.

What improvements have been made relative to previous generations of Bently Nevada software?



We listen to our customers. You've told us ways that our software could be enhanced to be even more user-friendly, flexible, and powerful. Consider this partial list of nearly 40 important enhancements that are present, or planned, for System 1 up through version 3.0:

- Totally configurable Enterprise/Plant/Asset/Point hierarchy
- Open Database — query with standard SQL tools
- Manual (keyboard) data entry in addition to offline and online data acquisition
- Tools for data manipulation to create calculated, derived, and “virtual” measurements
- Higher performance NetDDE client link
- Highly configurable archive module
- Windows NT®-compatible security model based on user log-in
- High-resolution static data trend
- More sophisticated static data storage
- 16 configurable spectral bands (with level alarms)
- 4 configurable alarms on every variable — choose from over, under, in-band, or out-of-band
- Configurable alarm severity model — any alarm can be assigned one of four severities
- Document management and linking
- Asset-specific properties
- Integrated offline and online data collection
- Simple & sophisticated static data correlation for multivariable trends — Drag-and-Drop
- Plot session “memorization” capabilities
- Integrated Decision SupportSM
- Plot cursor synchronization
- High-performance remote access

- Simultaneous data view/correlation from multiple sites
- Software integration of acceleration & velocity signals
- Dual navigation via hierarchy and graphical views
- Explorer-like hierarchy views — separate views arranged by logical enterprise and by instrument connections
- User-configurable bargraphs
- Collection Groups
- Real-time display updates
- Long-term data storage — user-defined historical database size
- On-the-Fly configuration changes
- Sophisticated event management
- Integrated configuration and display
- 2500 online points and 20,000 portable points per Data Acquisition Workstation
- Integration with existing Bentley Nevada software platforms (DM2000 & TM2000)
- Configurable tool bars
- Web-enabled and thin client support
- Totally flexible configuration and support for any asset — not just rotating machines
- Interfaces to CMMS/EAM applications

10

What can be expected in upcoming releases of System 1™ software?

Web-enabled and thin client support are planned in the very near future, significantly improving the ability to access your Asset Condition Management system from anywhere in the world on a wider variety of computing platforms and operating systems.

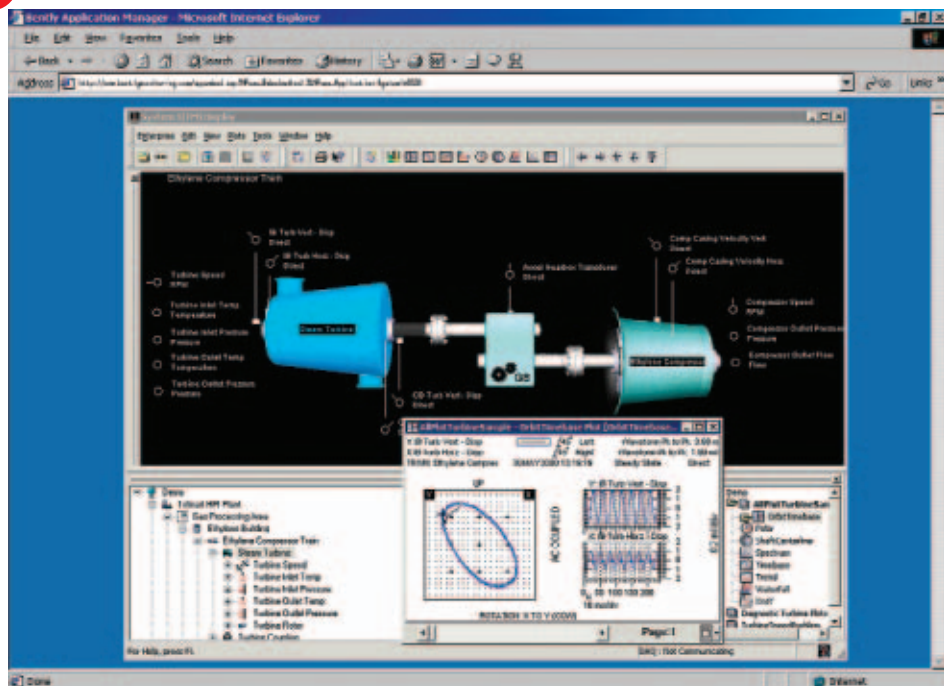


Table 1 summarizes features and functions released in version 2.0, and planned for versions 2.1 and 3.0 of System 1 software.

In addition, concurrent with the release of version 3.0, Bently Nevada will be introducing web-enabled and thin client features in System 1, allowing our display software to run in any internet browser, communicating with data acquisition server(s) over the internet, company intranet, or other private network. This enhancement will make it extremely easy for anyone – co-workers, suppliers, consultants, Bently Nevada support specialists, and others – to access System 1 software without the need to have our special display application loaded on their computer. All you need is a web browser and an internet, intranet, or company network connection and an appropriate password. This means our display environment will be supported on virtually any computing platform and operating system capable of running an appropriate internet browser.

CMMS/EAM integration is also planned, first with MRO Software's MAXIMO® system, and followed by SAP's R/3 Plant Maintenance module.

VERSION	FEATURE
2.0 (released)	Support for TDXnet™ communications processor with 3500 racks Addition of transient data format plots (cascade, Bode, and polar) Addition of Bently PERFORMANCE™ as a System Extender™ (plug-in module for System 1) providing thermodynamic performance monitoring OLE Automation interface with Microsoft® Excel for manipulating direct measurements and creating calculated, derived, and "virtual" values and points Real-time plot updates – waveform and static data High-resolution trend collection and configurable archiving Addition of new machine types (gas turbines, fans, reciprocating compressors) DDE interface for importing data from process control and historian systems
2.1	Provides plots specific to reciprocating compressors <ul style="list-style-type: none"> ▪ Pressure vs. Volume (5 variants) ▪ Rod Position ▪ Cylinder Performance calculations (14 values per cylinder) ▪ Gas Properties ▪ Cylinder Pressure Monitor Support ▪ Rod Position Monitor Support Plug-in support for Data Manager® 2000 and Trendmaster® 2000 software Static Data importing Context-sensitive right-click linking to external applications Addition of bearing database, an easily updateable and customizable library of over 20,000 rolling element bearings, highly useful for frequency-band alarming and custom rule creation in Decision Support module
3.0	Addition of Bently Decision Support™ as a System Extender (plug-in module) <ul style="list-style-type: none"> ▪ Embedded critical rotating machinery knowledge base ▪ RuleDesk custom rule creation utility ▪ Derived values from knowledge-base feature extraction Addition of notification capabilities (e-mail, beeper, network) OPC Server and Client modules (Data Access 2.0) for integration with process control and historian systems Support for TDXnet communications processor with 3300 racks Addition of compressor maps to Bently PERFORMANCE™ Custom Asset Support (Properties, Graphics) Reporting Module using interface to industry standard software Support for points configured as counters Ethernet support and other enhancements for communication with Snapshot™ for Windows® CE portable data collector Web-enabled and thin client support

"Bently Nevada will be introducing web-enabled and thin client features in System 1 ..."



SUMMARY

System 1 represents significantly expanded scope from Bently Nevada, with the ability to fulfill all of the functions required of the Asset Condition Management™ module in a Plant Asset Management System. It's an ideal place to start, and build from, as you implement asset management methodologies in your plant.

Considering that Bently Nevada has only recently expanded our capabilities to address more than rotating machinery, it is all the more remarkable that ARC lists us as the market leader in combined PAM and CM systems with these words: "Bently Nevada is the worldwide leader in the combined Condition Monitoring and PAM systems market and the only supplier with double-digit market share." *

To us, this statistic signifies that we've already helped you manage the condition of some of your most important assets – your rotating and reciprocating machinery – and that we can be trusted to provide a quality solution for managing your other assets as well. It's a new frontier, both for us and our customers, and one in which we're fully prepared to build on our existing mutual success. We invite you to learn more about System 1, and to put it to work in your plant, by contacting your nearest Bently Nevada Sales Professional and by visiting us online at www.bently.com ORBIT

Editor's Note: *Successfully managing plant assets requires not only the right tools, but also the behavioral changes necessary to embrace and use new methods for conducting business. To quote noteworthy management consultant, Ollie White, "You need clubs to play golf, but skill is in the hands of the user." In this article, we've focused exclusively on the tools. In a future issue of ORBIT, we will address the equally important topic of human factors needed for success.*

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